

CLAIMS

1. An ultrasound source comprising:  
an ultrasound transmitting element having an axis and a first cross-section along said axis, said ultrasound transmitting element having a first axial end and a  
5 second axial end, said first axial end operable to produce ultrasonic waves; and  
said first axial end comprising a matrix of ultrasound producing portions, said matrix having the first cross-section;  
wherein said ultrasound producing portions are formed by making a first series of parallel axial cuts in the ultrasound transmitting element and a second  
10 series of parallel axial cuts in the ultrasound transmitting element, and wherein said first series of parallel axial cuts and said second series of parallel axial cuts are approximately perpendicular.
2. The ultrasound source of claim 1 wherein said ultrasound transmitting element comprises a cylindrical horn and said first cross-section is a circle.
- 15 3. The ultrasound source of claim 1 wherein said ultrasound transmitting element comprises a flat horn and said first cross-section is rectangular.
4. The ultrasound source of claim 3 wherein said matrix of ultrasound producing portions comprises a row of ultrasound producing portions.
5. The ultrasound source of claim 1 wherein each one of said ultrasound  
20 producing portions has a first end proximal to the ultrasound transmitting element, a second end distal to the ultrasound transmitting element and a cross-section.
6. The ultrasound source of claim 5 wherein at least one of said ultrasound producing portions comprises a cross-section having an area with a maximum value at the first end and an area with a minimum value at the second end.
- 25 7. The ultrasound source of claim 6 wherein at least one of said ultrasound producing portions has a circular cross-section.
8. The ultrasound source of claim 1 wherein the first end radiates ultrasound toward a skin surface and causes cavitation in the coupling medium, at the skin surface or in the skin.
- 30 9. The ultrasound source of claim 1 wherein said first end comprises an anodized coating.

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10. The ultrasound source of claim 1 wherein said first end comprises carbide steel.
11. The ultrasound source of claim 10 wherein said carbide steel first end is bonded to said ultrasound transmitting element.
- 5 12. An ultrasound source comprising:  
an ultrasound transmitting element having an axis and a cross-section along said axis, said ultrasound transmitting element having a first axial end and a second axial end, said second axial end operable to produce ultrasonic waves;  
said cross-section having an area having a maximum value at the first axial  
10 end and a minimum value at the second axial end; and  
said first axial end comprising a matrix of ultrasound producing portions, said matrix having the first cross-section;  
wherein said ultrasound producing portions are formed by making a first series of parallel axial cuts in the ultrasound transmitting element and a second  
15 series of parallel axial cuts in the ultrasound transmitting element, and wherein said first series of parallel axial cuts and said second series of parallel axial cuts are approximately perpendicular.
13. The ultrasound source of claim 12 wherein said cross-section has a uniform shape and an area that decreases from a maximum value at the first axial end to a  
20 minimum value at the second axial end.
14. The ultrasound source of claim 12 wherein said ultrasound transmitting element has a circular cross-section along said axis.
15. The ultrasound source of claim 12 wherein the ultrasound transmitting element produces an ultrasound wave pattern that produces uniformly distributed  
25 cavitation.
16. The ultrasound source of claim 12 wherein the first axial end radiates ultrasound toward a skin surface and causes uniformly distributed cavitation in the coupling medium, at the skin surface or in the skin.
17. The ultrasound source of claim 12 wherein said first end comprises an  
30 anodized coating.

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18. The ultrasound source of claim 12 wherein said first end comprises carbide steel.

19. The ultrasound source of claim 18 wherein said carbide steel first end is bonded to said ultrasound transmitting element.

5 20. A method for producing homogenous cavitation at an area of skin comprising:

creating a volume of fluid adjacent the area of skin, said fluid having a uniformly dispersed concentration of cavitation nuclei therein; and

3 applying ultrasound to the volume of fluid from an ultrasound transmitting  
10 element having an axis and a cross-section along said axis, said ultrasound transmitting element having a first axial end and a second axial end, said second axial end operable to produce ultrasonic waves, said first axial end comprising a matrix of ultrasound producing portions, said matrix having the first cross-section, wherein said ultrasound producing portions are formed by making a first series of  
15 parallel axial cuts in the ultrasound transmitting element and a second series of parallel axial cuts in the ultrasound transmitting element, and wherein said first series of parallel axial cuts and said second series of parallel axial cuts are approximately perpendicular;

20 wherein the ultrasound causes cavitation to begin at or around the cavitation nuclei.

21. The method of claim 20 wherein the cavitation nuclei comprise appropriately sized ceramic particles.

22. The method of claim 20 wherein the cavitation nuclei comprise appropriately sized polymer particles.

25 23. The method of claim 20 wherein the cavitation nuclei comprise appropriately sized titanium dioxide particles.

24. The method of claim 20 wherein the cavitation nuclei comprises gas bubbles.

25. The method of claim 20 further comprising delivering a substance through the area of skin.

30 26. The method of claim 20 further comprising extracting analyte through the area of skin.

27. A method for producing homogenous cavitation at an area of skin comprising:

creating a volume of fluid adjacent the area of skin, said fluid having a uniformly dispersed concentration of a fluorocarbon therein, said fluorocarbon facilitating the production of cavitation; and

applying ultrasound to the volume of fluid;

wherein the ultrasound causes cavitation in the fluid, evaporation of the fluorocarbon and the creation of gas bubbles in the coupling medium.

28. The method of claim 27 further comprising delivering a substance through the area of skin.

29. The method of claim 27 further comprising extracting analyte through the area of skin.

30. A method for producing homogenous cavitation at an area of skin comprising:

creating a volume of fluid adjacent the area of skin, said fluid having a uniformly dispersed concentration of a first substance therein, said first substance facilitating the production of cavitation;

applying ultrasound to the volume of fluid;

wherein the ultrasound causes cavitation in the fluid; and wherein the first substance is a surfactant that facilitates the occurrence of cavitation when the coupling fluid is exposed to ultrasound.

32. The method of claim 30 further comprising delivering a substance through the area of skin.

33. The method of claim 30 further comprising extracting analyte through the area of skin.

34. A method for producing homogenous cavitation at an area of skin comprising:

providing an ultrasound source to apply an ultrasonic wave to the area of skin;

positioning a screen between the area of skin and the ultrasound source, the screen having a number of openings therein; and,

applying ultrasound to the area of skin through the screen;

wherein the openings in the screen nucleate cavitation and filter cavitation bubbles by size thereby producing a homogenous bubble population.

5 35. The method of claim 34 further comprising delivering a substance through the area of skin.

36. The method of claim 34 further comprising extracting analyte through the area of skin.

37. An ultrasound device comprising:

an ultrasound horn; and

10 a housing for said ultrasound horn, a portion of said housing having a reduced inside diameter relative to a diameter of said horn;

a screen positioned between an area of skin and the ultrasound horn, the screen having a number of openings therein;

15 wherein the reduced inside diameter focuses ultrasonic energy on a small area of skin; and

38. The ultrasound device of claim 37, wherein said reduced inside diameter is located near the skin.

39. The ultrasound device of claim 37, further comprising  
20 a coupling medium contained in said housing.